NJAPPA
New Jersey Chapter of APPA

Welcomes you to the

Spring General Membership Meeting

June 13, 2024

RUTGERS

Overview of APPA 1000

APPA's Standard on Total Cost of Ownership

Presented by:

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Princeton, University

June 13, 2023

Credit(s) earned on completion of this course will be reported to American Institute of Architects (AIA) Continuing Education Session (CES) for AIA members.

Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions to specific materials, methods or services will be addressed at the conclusion of this presentation.

AIA Approved Continuing Education

Course Description

This session will walk participants through the impetus behind and the development of APPA's standard on Total Cost of Ownership. An overview of the standard, along with discussing use cases of applicable scenarios, is intended to provide attendees with an understanding of the standard, how it could be applied, and how it might impact their operations at all levels of the organization.

AIA Continuing Education Provider

Learning Objectives

1. To become familiar with or greater understanding of APPA's published standard for total cost of ownership modeling.
2. To be able to evaluate case studies on how the standard might apply to various situations.
3. To workshop modeling the TCO principles in sample scenarios to help them gain additional familiarity.
4. Have the ability to utilize the standard and have effective discussions about implementation within their operations.

Tale of Two Buildings…

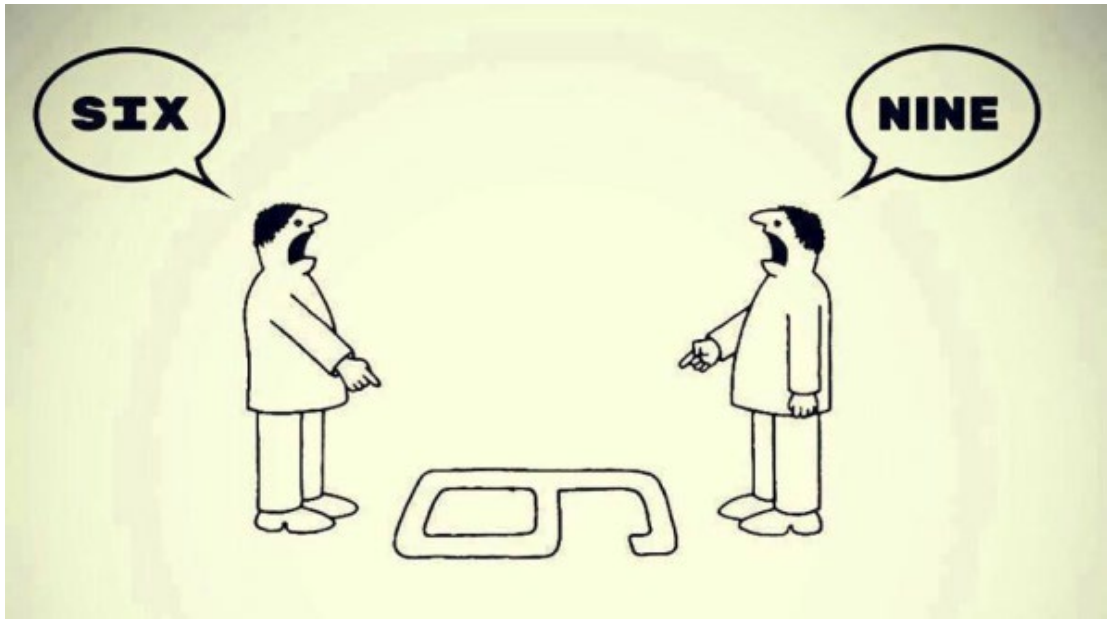
- Interdisciplinary High Performance Computing Center
- **Estimated Cost: $274,217,000**

- Interdisciplinary High Performance Computing Center
- **Estimated Cost: $822,651,000**

What differences would lead to such divergent costs???

Only One…

Perspective!



What is your familiarity with Total Cost of Ownership?

slido

What is your familiarity with Total Cost of Ownership (TCO)?

ⓘ Start presenting to display the poll results on this slide.

What is your familiarity with the APPA Standard on TCO?

slido

What is your familiarity with the APPA Standard on TCO

ⓘ Start presenting to display the poll results on this slide.

What concerns do you have about pursuing a TCO initiative?

slido

What concerns do you have about pursuing a TCO Initiative?

ⓘ Start presenting to display the poll results on this slide.

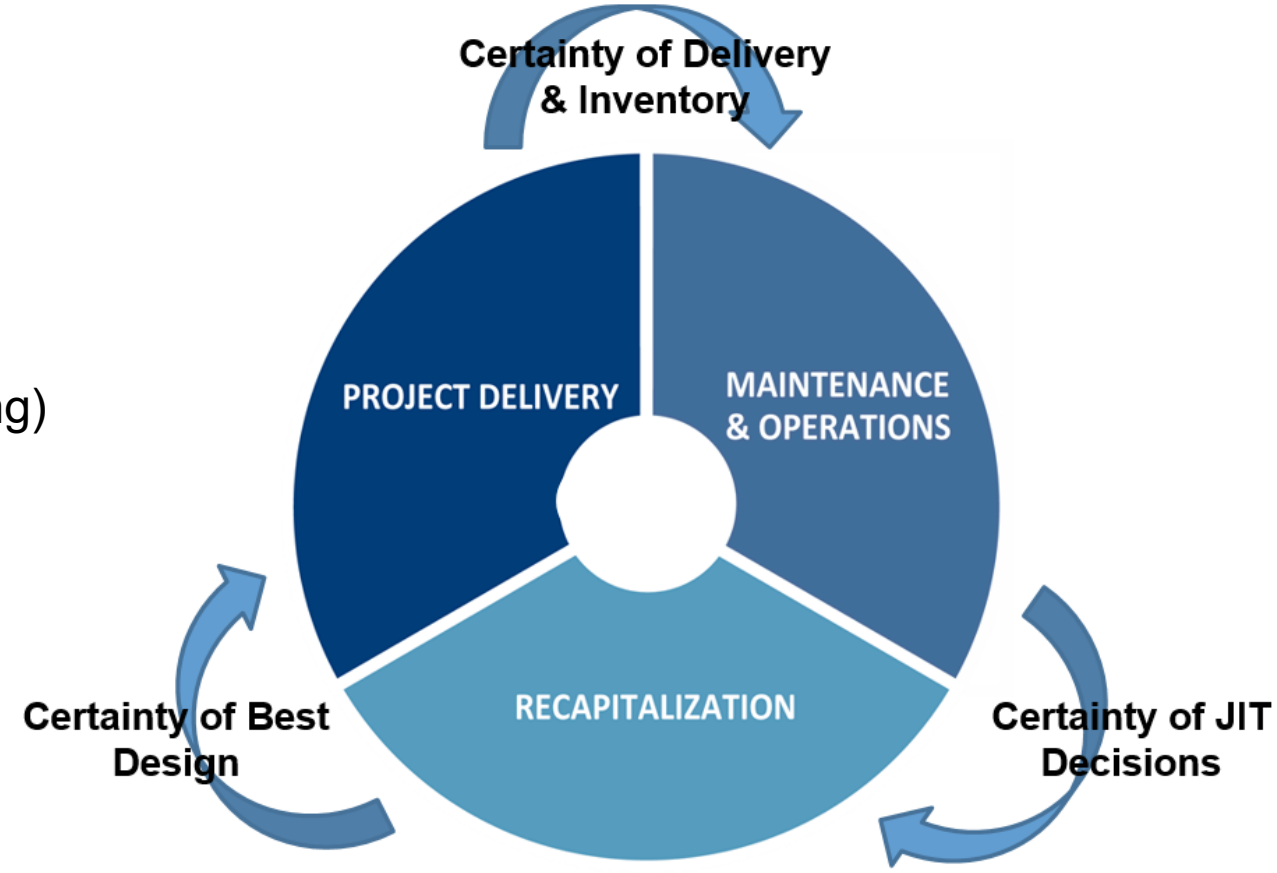
TCO Defined

- **From the Standard…**
  - A holistic approach to maximizing return on investment of managed physical assets that **includes the summation of all known and estimated costs** to include first, recurring, renewal / replacement, and end-of-useful life costs revised at critical decision points to aid in life-cycle asset management decisions.

- **From *Buildings: The Gifts that Keep on Taking…***
  - TCO includes the **total present value of all direct, indirect, reoccurring, and non-reoccurring costs incurred** or estimated to be incurred in the design, development, production, operation, maintenance, and renewal of a facility, structure, or asset over its anticipated life span.

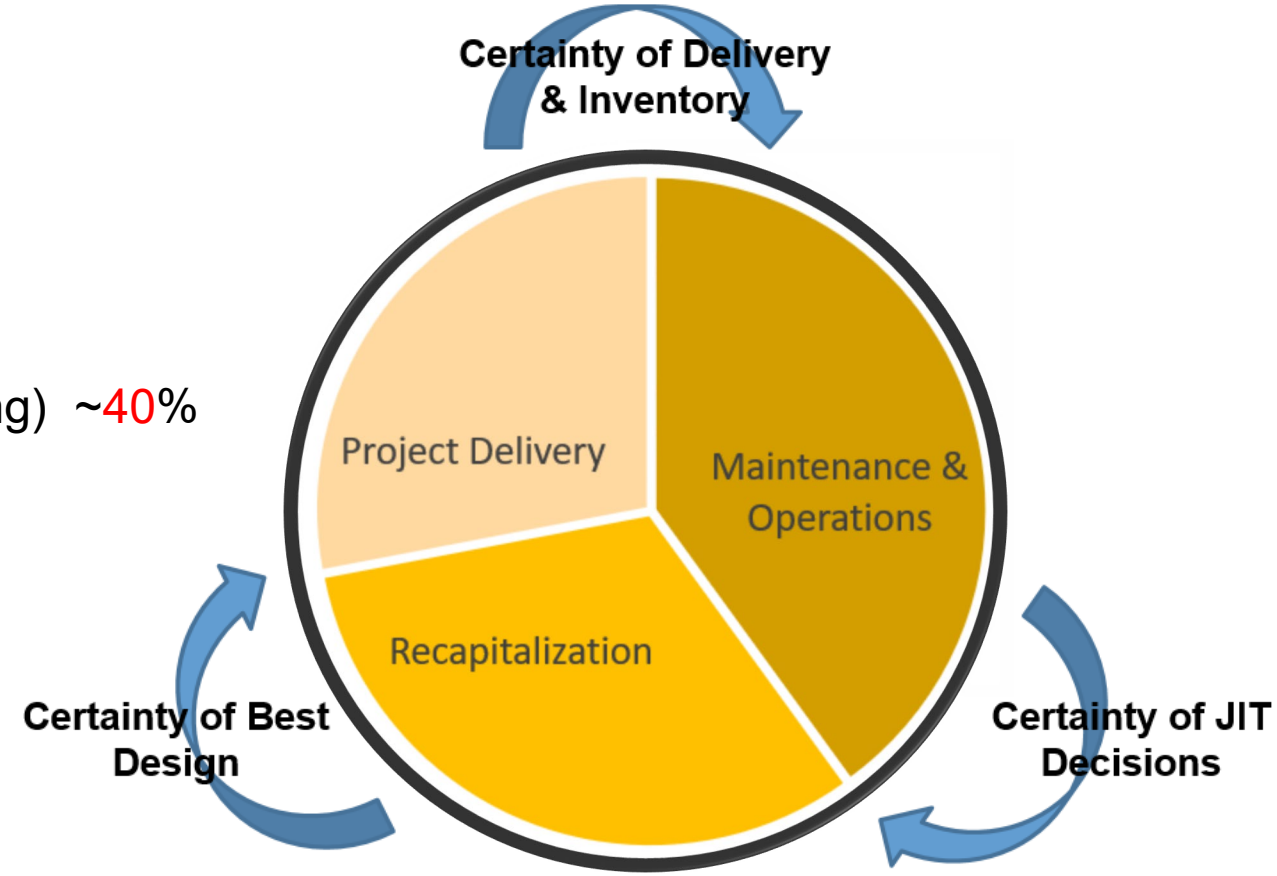
Graphical Representation of TCO

- Project Delivery (One Time)
  - Acquisition
  - Planning & Programming
  - Design
  - Construction
  - Commissioning
  - Demolition, Disposal, Adaptive Reuse
- Operations & Maintenance (Annual Reoccurring)
  - Overhead & Administration
  - Preventive Maintenance
  - Reactive Maintenance
  - Utilities
- Recapitalization (Periodic Reoccurring)
  - Asset Replacement
  - Asset Retrofit
  - Programmatic Upgrades
  - Improvements & Enhancements



Graphical Representation of TCO

- Project Delivery (One Time) ~28%
  - Acquisition
  - Planning & Programming
  - Design
  - Construction
  - Commissioning
  - Demolition, Disposal, Adaptive Reuse
- Operations & Maintenance (Annual Reoccurring) ~40%
  - Overhead & Administration
  - Preventive Maintenance
  - Reactive Maintenance
  - Utilities
- Recapitalization (Periodic Reoccurring) ~32%
  - Asset Replacement
  - Asset Retrofit
  - Programmatic Upgrades
  - Improvements & Enhancements



APPA 1000

Part 1

- Definition
- Framework
- 13 Key Principles

Part 2

- Structure
- Relationships between the principles
- Implementation
- Data Elements

Part 1 – Key Principles

TCO Formula & Framework

$$\text{TCO} = \sum C_a + \sum C_b + \sum C_c + \sum C_d + \sum C_e$$

Where:

C_a = **Initial Asset Costs** / First Cost (one Time)

C_b = Cost of **Operations and Maintenance** (Annual Recurring)

C_c = Cost of **Utilities** (Annual Recurring)

C_d = Cost of **Renewal** (Periodic Recurring)

C_e = Cost at **End of Useful / Functional Life** (One Time)

Total Cost of Ownership Framework	
A	**Initial Asset Costs / First Costs (One Time)**
A.1	Planning and Programming
A.2	Acquisition
A.3	Design
A.4	Construction/Site Development
A.5	Commissioning
B	**Operations and Maintenance (Recurring)**
B.1	Lease or Rental
B.2	Maintenance
B.3	Operations
B.4	Overhead and Administration
C	**Utilities (Recurring)**
D	**Renewal**
D.1	Replacement
D.2	Programmatic Upgrades
D.3	Improvements/Enhancements
E	**End of Useful / Functional Life (One Time)**
E.1	Sale/Adaptive Reuse
E.2	Re-sale Value/Salvage Value
E.3	Removal
E.4	Site Restoration/Remediation
E.5	Deconstruction/Recycling

13 TCO Principles

Foundation

- **Managed Assets** shall be applicable to land parcels, facilities, structures, infrastructure, and equipment.
- A detailed **Asset Inventory** shall be maintained.
- All fixed assets shall be located using a **Global Location Hierarchy** using a globally unique identifier.
- All assets shall be organized using an **Asset Classification standard**.

Integrity

- **Asset Information Sharing** shall be implemented to ensure data collection is minimized and to ensure everyone is working from the same data for decision making.
- Comprehensive and continuous **Asset Reporting** shall be implemented to convey key information about all assets throughout the organization to support planning and decision-making.
- Accurate information founded on good **Data Management and Verification** strategies shall be implemented organizationally.

13 TCO Principles

Information Gathering

- **Asset Costing** shall use the standard TCO framework.
- A continuous process of **Asset Inspection** shall be initiated as part of everyday business.
- **Asset Performance** is a key metric that shall be assessed as a baseline and during normal operation to ensure optimum efficiency.

Decision Making

- **Asset Decisions** shall be made based on a Strategic Asset Management Plan.
- **Asset Annual Funding** shall be projected for the near and long term and updated annually.
- An **Asset Comprehensive Plan** shall be developed for each asset.

Structure of TCO Principles

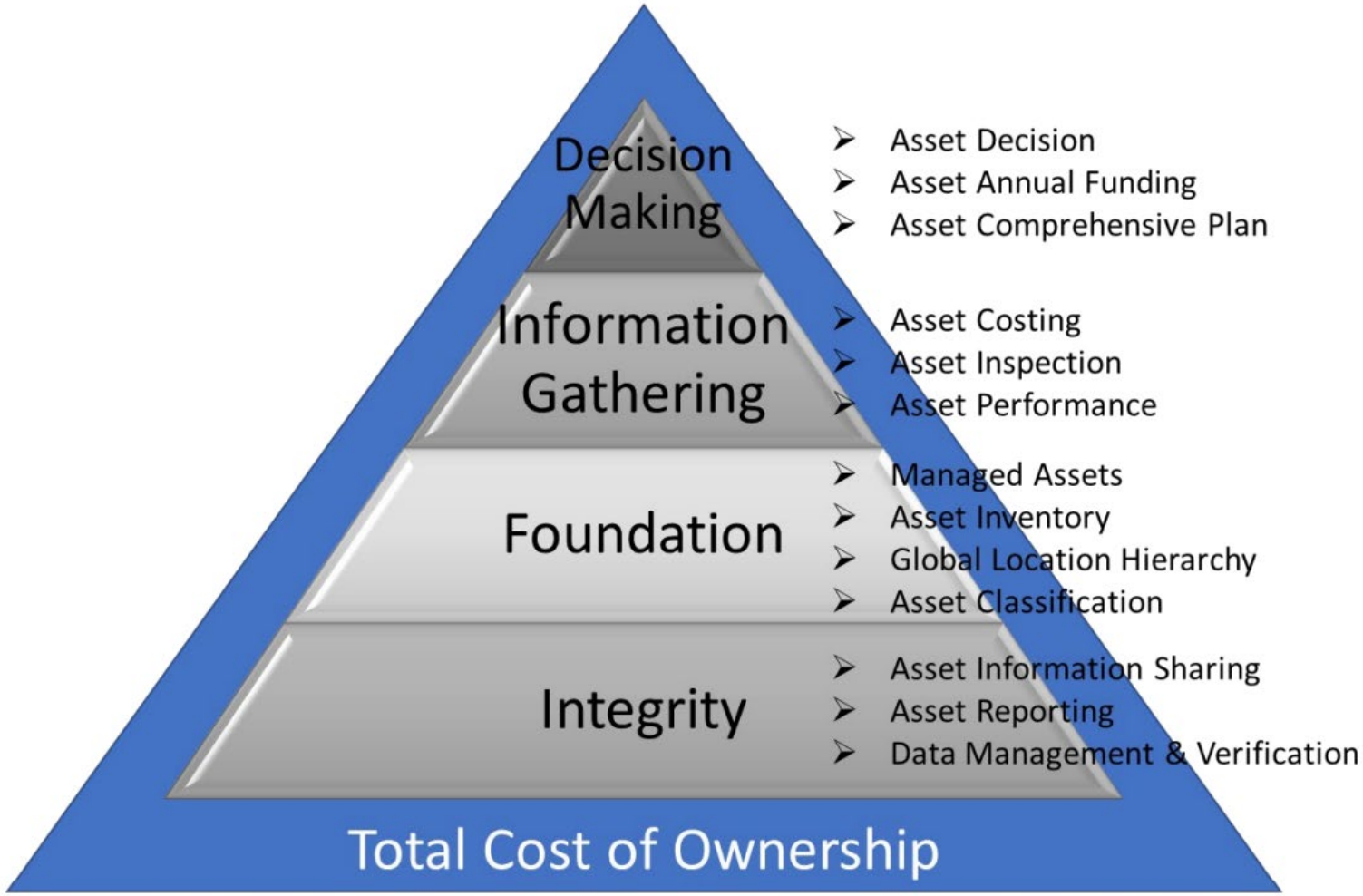
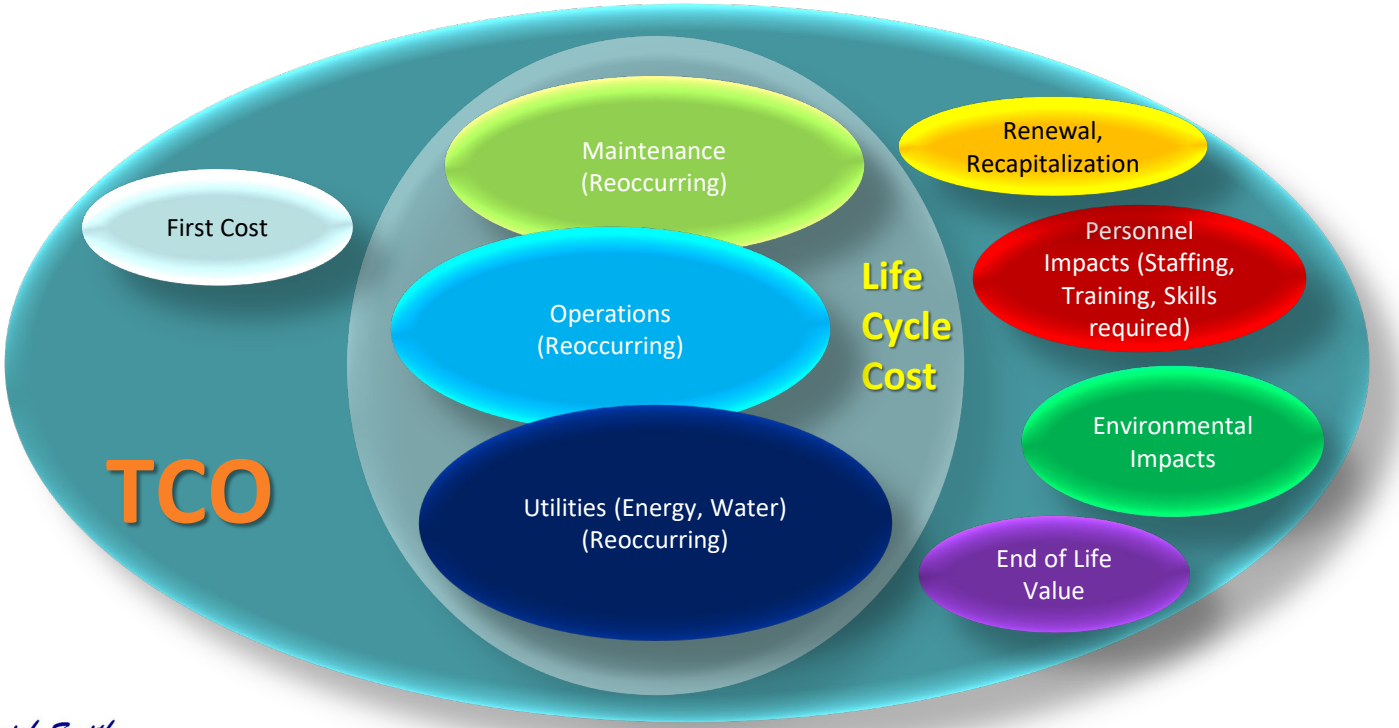


Figure 3 – Structure of TCO Principles

Scope of APPA Total Cost Of Ownership



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Part 1 – Section 3.3.5

Part 2 – Implementation & Data Elements

What Can You Do With TCO?

- **Current Decision Making** (Current Year) [12]
  - Product selections (LCCA)
  - Maintenance Decision impacts
  - Identifying problem areas in performance or breakdowns
- **Near Term Decision Making (**Next Year to Five Years) [20]
  - Resource leveling and allocation
  - Assessing risk
  - Supporting budget decisions
- **Long Term Decision Making** (Five Years to Twenty-five Years) [14]
  - More agile long-term planning
  - Identifying structures to retire
  - Looking at TCO of assets
- **End of Life Decision Making** (Planning for EOL) [4]
  - Residual value
  - Remaining useful life
  - Run to failure decisions

50 Uses Defined – Here is a Summary

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Mandatory Requirements for Implementation

	Principle (Part 1)	Shall Statement Goal (Part 1)	Implementation Goal (Part 2)	Minimum Acceptable Implementation of TCO (Part 2)
Integrity	Asset Information Sharing (P1-3.3.11)	A framework with associated processes to share and protect information about the managed assets to authorized individuals shall be developed. An authoritative source for all managed assets shall be identified.	Implement framework that begins in the intial phases of acquistion with associated processes to share and protect all information about the managed assets to authorized individuals (as deemed appropriate.) Identify the authoritative source for the managed asset responsible for the accuracy of the data.	Data is collected and shared at appropriate times with decision-makers. Identify the authoritative source for all managed asset data responsible for the accuracy of the data.
	Asset Reporting (P1-3.3.12)	Establish timely and meaningful asset reporting for internal and external use based on accepted accounting practice, regulatory or non-regulatory requirements.	Establish continuous and periodic hierarchical reports to satisfy organizational needs for effective planning, efficient resource management, risk managment, resiliency, continuous improvement, and to produce the greatest possible ROI for the managed assets. -Establish regulatory and non-regulatory reporting.	Develop reports to include location, criticality, performance, useful life and known associated costs for all managed assets.
	Data Management and Verification (P1-3.3.13)	Based on an established business process, ensure information is collected one time from the authoritative source, that it is verified, sustained, includes metadata, and is repurposed, to the greatest extent possible.	Develop internal controls and accountability measures to collect managed asset data one time, sustain, and validate that data at appropriate times by authoritative source(s).	Ensure data is collected, sustained and validated with the least amount of duplication by authoritative source(s).
Foundation	Managed Asset (P1-3.3.1)	Identify assets for management of facilities and infrastructure and assign a priority that corresponds to its relative criticality to the organization mission	Develop a comprehensive list of all managed assets to include components that are critical to the achievement of the organization's mission.	Develop a list of managed assets or group of managed assets that align with the achievement of the organization's mission.
	Asset Inventory (P1-3.3.2)	A comprehensive database shall be created and maintained of all managed assets using a recognized standard asset taxonomic classification system and parent-child relationships	A comprehensive database shall be created and maintained of all managed assets along with their parent-child relationships.	A database will be created to store all managed assets and subsequent data identified in the TCO Principles.
	Global Location Hierarchy	Identify a unique asset location for all managed	A unique global location for all managed assets will	Identify a standard location for all managed assets. These locations may be in reference to local

Data Elements Tables

Seq	Common Name	Appendix A Reference	Data Element	Level	Unit Type	Purpose	Data Element Definition	Key Principle Associated	Data Source	Numeric/Text
1	Asset Name	N/A	ASSET_NAME	1	N/A	Identification	The name of the asset	01. Managed Assets	Manual	Text
2	Asset Description/Definition	N/A	ASSET_DESCR	2	N/A	Unique identification	A brief passage used to describe the scope and typical contents of the class in question. Usually not normative.	01. Managed Assets	Manual	Text
3	Asset Abbreviation	N/A	ASSET_ABREV	2	N/A	Short descrition or common reference	Abbreviations and acronyms that are often referenced with respect to the subject matter of a specific classification. In some cases, the Classification Title may be commonly referred to with an abbreviation or acronym, which is typically cited as an informative cross reference to assist users.	01. Managed Assets	Manual	Text
4	Asset Type	N/A	ASSET_TYPE	2	N/A	Type	Indicator of asset type - Object, O&M (Service Contract), Custodial, Facility, Grounds, or Parcel	01. Managed Assets	Manual	Text
5	Asset Status	N/A	ASSET_STATUS	2	Each		The current contition of the asset	02. Asset Inventory	Manual	Text
6	Asset Criticality	N/A	ASSET_CRITICAL	2	N/A		The criticality of the asset to the organization	02. Asset Inventory	Manual	Text
7	Asset Current Replacement Value	N/A	ASSET_CRV	2	$ USD	For Cost Principle	The eplacement cost of the asset	02. Asset Inventory	Manual	Num
8	Asset Installation Date	N/A	ASSET_INSTALLED	2	Date		The date the asset was installed	02. Asset Inventory	Manual	Num
9	Asset Age	N/A	ASSET_AGE	2	Years	Life Cycle	The age of the asset	02. Asset Inventory	Manual	Num
10	Asset Life Expectancy	N/A	ASSET_LIFE_EXP	2	Years	Manufacturer	The life expentency of the asset	02. Asset Inventory	Manual	Num
11	Risk Level	N/A	ASSET_RISK_LEVEL	2	Each	Reliability	The level of risk of failure	02. Asset Inventory	Manual	Text
12	Bar Coding	N/A	ASSET_BAR	1	Each		Labeling and location each building component for reliable tracking and cross referencing equipment to the CMMS systems PM programs, Manuals, Parts lists and history.	03. Global Location Hierarchy	Manual	Text
13	Asset location	N/A	ASSET_LOC	2	N/A	Location	The actual location of the asset. This is important in differentiating onne asset from another. A geospatial locator is optimum.	03. Global Location Hierarchy	Manual	Text
14	Underground Utilizes / Assets	N/A	ASSET_VISABILITY	2	N/A	Visability of asset	Graphically locate Underground utilities. Exercise valves and recommended frequencies. Inspect pit's, manholes, and vaults for deficiencies, and environmental conditions and take corrective actions.	03. Global Location Hierarchy	Manual	Text
15	Classification Title	N/A	CLASS_TITLE	1	N/A		The title used to identify the class. Usually communicates in simple language the scope of the class concept. Normative in most cases.	04. Asset Classification	Manual	Text
16	Classification Identifier	N/A	CLASS_ID	1	N/A		A combination of letters or numbers used to communicate information about a class. Typically human-interpretable. Normative in most cases.	04. Asset Classification	Manual	Text
17	Global Unique Identifier	N/A	GUID	1	N/A		A Globally Unique Identifier, which can be used as a class key for web-based and collaborative applications. Normative, not human-interpretable. See https://en.wikipedia.org/wiki/Globally_unique_identifier	04. Asset Classification	Manual	Text
18	Initial Asset Cost (C.)	A	IAC	1	$ USD	Collecting and	Summation of all Initial Asset Cost (C.)	05. Asset Costing	Manual	Num

Implementation of Principles

- Key Principle
  - Relationship to other Principles
    - The “Why”…
      - The “What”…
        - Basic Implementation
        - Mid-Level Implementation
        - Full Performance Implementation
      - The “How”…
  - Results
  - Next Steps
  - Implementation Notes

Example from the Standard:

Managed Assets

Mission

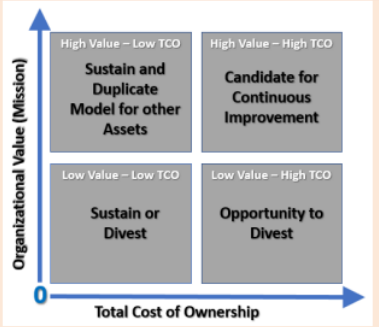
A complete set of defined assets aligned with the organization's mission creates the foundation of TCO. This foundation serves as the starting point for all TCO principles to support organizational objectives, goals, and organizational value (such as financial growth and sustainability and customer satisfaction).

Shall Statement: Organizations shall identify facilities and infrastructure assets and assign a priority that corresponds to the relative criticality of each to the organization mission. This step creates the foundation for alignment of assets and their connection to all organizational functions.

This might be a daunting task for an organization that is asset intensive. For manageability, the task may start with the identification of only those assets that are critical to achievement of the organization's mission, with additional assets added over time. As additional assets are added, their relative criticality will be identified as well.

Purpose

The purpose of this principle is to identify the assets that become the foundation for TCO. To manage assets effectively, assets shall be identified, inventoried, and prioritized. While organizations exist at various levels of maturity and with various needs, the purpose of this principle enables the organization to manage assets, thus enabling methods to track TCO and provide significant value for the organization. As noted above, by identifying the criticality of each asset to the organization mission, it is possible to narrow the focus of TCO for decision-making purposes, including decisions represented by the following graphic:



Example from the Standard: *Managed Assets*

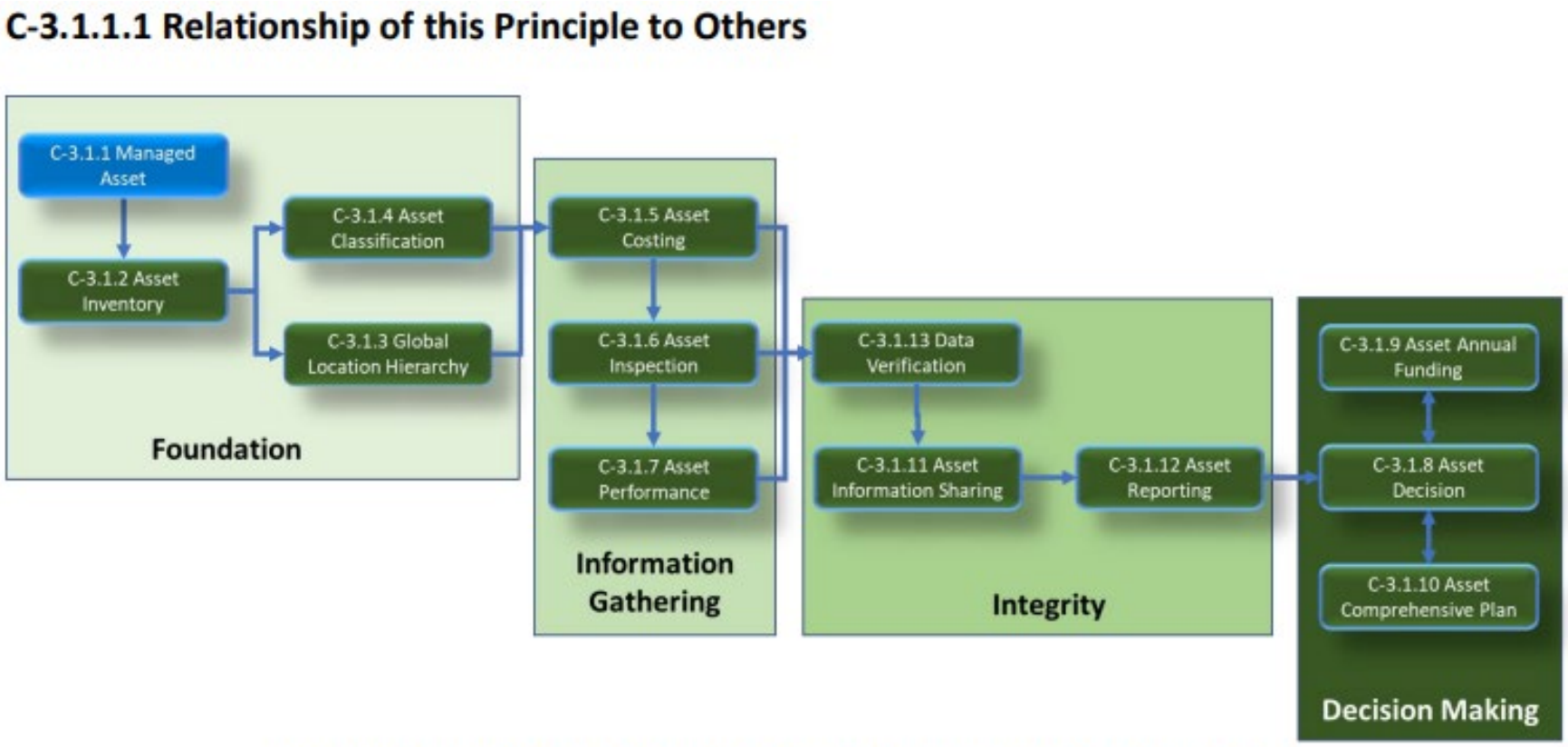


Figure C-1 - Relationship of Managed Asset to Other Principles

Example from the Standard: *Managed Assets*

- The Why…
  - *The activities within this principle, and its sister principles including Asset Inventory, Asset Classification, and Global Location Hierarchy, are **foundational to all other principles** in that identification and location of assets in a management system provides the framework for development of a Strategic Asset Management Plan (SAMP) that aligns assets with business objectives.*

Example from the Standard: *Managed Assets*

- The What…
  - *Assets are connected to business objectives by identifying their relative importance to specific business outcomes. Standard methods for establishing this connection* ***include a prioritization-based ranking and a risk assessment that are combined into a "prioritization matrix," which is described in the following section****. The result is a list of assets that is prioritized based on importance to specified business outcomes, along with associated risk factors that describe the probability that each outcome will be achieved. This list with associated risks is the basis for developing effective business strategies for managing assets in a way that is aligned with business objectives.*

Example from the Standard: *Managed Assets*

- The How…
  - *Assets should be **prioritized** by*
    - ***Value** (criticality or impact to mission – cost, customer service, innovation, revenue…) and*
    - ***Business risk** (using an appropriate risk scale that includes things like loss of life or property, business loss, damage to public image/integrity, revenue/funding impairment, environmental impact, mandatory reporting needs, regulatory requirements, etc.)*
  - *It is important to note that the prioritization matrix should not include asset specific information such as age, condition, or performance. Information about age, condition, and performance will be overlaid onto the asset prioritization later in the TCO development process [see Asset Costing (P1-3.3.5), Asset Inspection (P1-3.3.6), and Asset Performance (P1-3.3.7)].*

Example from the Standard: *Managed Assets*

- Results
  - *The Managed Asset principle* ***will provide the basis for narrowing the focus of an organization to those assets that deliver the greatest value****, or in other words, are most critical to the achievement of organizational goals. It supports the development of a Strategic Asset Management Plan and is a prerequisite for carrying out the other principles in TCO. It is reasonable to expect that the first application of the Managed Asset principle will be at a high level to ensure sustainability and support continuous improvement.*

Example from the Standard: *Managed Assets*

- Next Steps
  - *The output of the Managed Asset principle will be the basis for developing an **Asset Inventory**.*

Practical Example

- Asset Profile: 1,000 Cooling Ton Chiller
  - Screw-type Chiller
  - 12,000,000 BTUs
  - 1,560 Annual Runtime Hours
    - 12 hours per day, 5 days per week, 26 weeks per year
  - Installed in 2010
  - Estimated Lifecycle is 25 Years

Focus on the concept, not the numbers.

First Cost Application

- Considers initial project delivery.
- Information is in a binder, in a folder, on a network, etc. and is only accessed when needed.
- No planning. Costs considered sunk.

A	Initial Asset Costs / First Costs (One Time)	$	1,312,500
A.1	Planning and Programming	$	50,000
A.2	Acquisition		
A.3	Design		
A.4	Construction / Site Development	$	1,250,000
A.5	Commissioning	$	12,500

Typical Condition Assessment

- 10-year Snapshot
- Considers assets that will require attention within those 10 years.
  - Installed in 2010
  - 14 years in operation
  - 11 years remaining in lifecycle
- Current planned replacement value of the chiller…

Nothing!!!

O&M Planning

- Most operations plan O&M in aggregate and not at the asset level.
- Consider…
  - Planned maintenance
  - Reactive maintenance
  - Repairs
  - Some Administrative
  - Utilities
- **Total annual planned value…** **$677,210 / Year**

		Annual Value	Lifetime Value
B	**Operations and Maintenance**	**$ 19,015**	**$ 475,382**
B.1	Lease or Rental	$ -	$ -
B.2	Maintenance	$ 12,000	$ 300,000
B.2a	Repairs *	$ 6,535	$ 163,382
B.3	Operations	$ -	$ -
B.4	Overhead and Administration	$ 480	$ 12,000
C	**Utilities ** **	**$ 658,195**	**$ 16,454,880**
	Total of B + C	**$ 677,210**	**$ 16,930,262**

* $5k per year for 1 - 5 and 3% increase annually up to year 25.

** Assumes 12 MMBTU > 3,516 kW * 1,560 annual runtime hours @ $0.12 per kWh

Lifecycle Analysis

- CRV / Lifecycle = Annual Lifecycle Value
- Current Replacement Value $1,500,000
- Lifecycle: 25 years
- Annual Lifecycle Value: $60,000 / year

- **If we combine O&M and Lifecycle, the annual asset funding is…** **$737,210 / Year**

Total Cost of Ownership

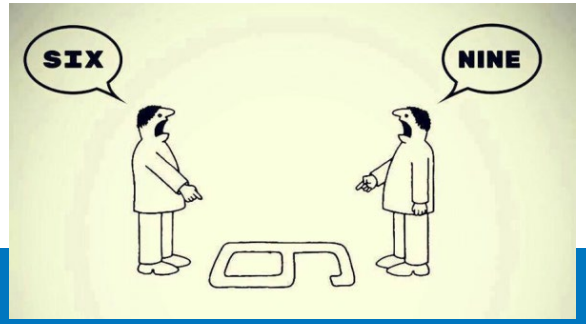
- All costs considered
  - O&M
  - Utilities
  - Renewal
  - Replacement
  - Disposal
- Annual TCO Value of the Chiller…

$831,426 / year

		Annual Value	Lifetime Value
A	**Initial Asset Costs / First Costs (One Time)**		**$ 1,312,500**
A.1	Planning and Programming	SUNK	
A.2	Acquisition		$ 50,000
A.3	Design		
A.4	Construction / Site Development		$ 1,250,000
A.5	Commissioning		$ 12,500
B	**Operations and Maintenance**	**$ 19,015**	**$ 475,382**
B.1	Lease or Rental	$ -	$ -
B.2	Maintenance	$ 12,000	$ 300,000
B.2a	Repairs *	$ 6,535	$ 163,382
B.3	Operations	$ -	$ -
B.4	Overhead and Administration	$ 480	$ 12,000
C	**Utilities ******	**$ 658,195**	**$ 16,454,880**
D	**Renewal**	**$ 61,600**	**$ 1,540,000**
D.1	Replacement	$ 60,000	$ 1,500,000
D.2	Programmatic Upgrades ***	$ 800	$ 20,000
D.3	Improvements / Enhancements ****	$ 800	$ 20,000
E	**End of Useful Life / Functional Life**	**$ 6,000**	**$ 150,000**
E.1	Sale / Adaptive Reuse	$ -	$ -
E.2	Re-sale / Salvage Value	$ -	$ -
E.3	Removal	$ 6,000	$ 150,000
E.4	Site Restoration / Remediation	$ -	$ -
E.5	Deconstruction / Recycling	$ -	$ -
		$ 831,426	**$ 20,785,645**

* $5k per year for 1 - 5 and 3% increase annually up to year 25.
** Assumes 12 MMBTU > 3,516 kW * 1,560 annual runtime hours @ $0.12 per kWh
*** $10,000 overhaul at years 10 and 20
**** $5,000 per 5 years for technology upgrades

$1.5 Million >>> $20.7 Million



How the 13 Principles Apply

Principle	Data
1 - Managed Asset	Yes
2 - Asset Inventory	Chiller Inventory Equipment Metadata
3 - Global Location Heirarchy	Central Plant, Main Campus
4 - Asset Classification	Screw-type Chiller OmniClass #23-33 21 13 21 11
5 - Asset Costing	Estimated TCO = $20,785,644
6 - Asset Inspection	Asset Condition assessed as Good Few immediate repairs. No Retrofits needed. Periodic PM Inspections Annual Inventory Audit Current FCI of Asset = 0%
7 - Asset Performance	Operation SOPs & Metrics
8 - Asset Decision	Asset Priority is Critical
9 - Asset Annual Funding	Estimated Annual Funding = $831,426
10 - Asset Comprehensive Plan	Operational Strategic Asset Management Plan
11 - Asset Information Sharing	Operationally defined system of record
12 - Asset Reporting	Operationally defined reports
13 - Data Management and Verification	Operational Data Audit Procedures

That's nice… What do I do with this?

- Purchase a copy of the standard from the APPA Bookstore.
- Discuss specific use-cases for application at your operation.
  - New Construction
  - System Replacement
  - Asset Recapitalization Planning
  - Condition Assessment
  - Long-range Planning
  - And more…
- Talk to your providers (CMMS, IWMS, BMS, etc.) on how they might be able to support the APPA standard.
- Look for additional resources coming out of APPA to support implementation.
- Reach out to the APPA TCO Leaders for additional questions.

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THANK YOU!

This concludes The American Institute of Architects Continuing Education Systems Course